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THE THURMAN-WILSON FAULT THROUGH SOUTHWESTERN IOWA, AND ITS BEARINGS¹

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WHY THE EXTENSION OF THE FAULT HAS BEEN OVERLOOKED

It may seem remarkable that an important fault should extend from near the southwest corner of Iowa to the central part of the state, with indications that it may actually extend to the "Driftless Area," and very little evidence of the presence of such a fracture exist in the literature of the state.² There are, however, reasons for this lack of previous recognition. The strata of the Missouri stage of the Pennsylvanian, in and beneath which nearly all of the displacement in southwestern Iowa took place, is concealed over

¹ Published with the approval of the director of the Iowa Geological Survey.

² The following important references may be noted:

J. E. Todd, "On the Folding of the Carboniferous Strata in Southwestern Iowa," *Proceedings of the Iowa Academy of Science*, I, Part I (1889), 61; "Some Varied Conclusions in Iowa Geology," *ibid.*, XIII (1906), 184.

G. L. Smith, "Carboniferous Section of Southwestern Iowa," *Iowa Geol. Surv.*, XIX (1909), 612.

C. R. Keyes, "Controlling Fault Systems of Iowa," *Proc. of the Iowa Acad. of Sci.*, XXIII (1916), 103; "Extent and Age of the Cap-au-Gres Fault," *ibid.*, XXIV (1917), 61.

Keyes's 1916 article was published during the summer, a year later than the field work by which the present writer discovered that near Stennett the Thurman-Wilson fault of Todd and Smith did not become an anticline but continued as a fault. In Keyes's two papers he is chiefly concerned with the Fort Dodge and the Cap-au-Gres faults, but in spacing the faults in his first paper he represents the "Red Oak fault" (the term he uses for Todd and Smith's fault between Thurman and Wilson quarries) as extending far to the northeast without giving any reason for opposing Smith's view that the fault became an anticline near Stennett, and calls the throw four hundred feet instead of three hundred feet, as reported by Smith. He also continues this fault line west to Hebron, Nebraska, without stating his reason for disagreeing with the geologists of Nebraska. However, it should be noted that near Bloomington in Franklin County, about seventy-three miles west of Hebron, Professor Erwin H. Barbour mentions and illustrates "one major and several minor faults of one to four feet displacement" (*Nebraska Geol. Surv.*, IV, Part VII, Pl. 12).

much of the area by a thick deposit of Dakota sandstone; and the entire area is deeply covered with drift, through which almost no outcrops of underlying strata appear. Especially is this true of the Missouri stage in the northern half of the area, the area north of the fault plane. Further, the Missouri stage in southwestern Iowa is represented by fourteen different sets of limestone beds separated by intervening beds of shale. The limestones themselves have shaly partings of various thicknesses, and the shaly members have limestone beds. Through all these beds there are the same species of fossils and the same general assemblage of forms, so that at present, at least, the worker who uses the fossils must associate the assemblage and relative abundance of fossils with the sequence of the beds. In this way a few lines of evidence can be made out that have an important bearing. Detailed work later on the fossil content and the relation of each bed will doubtless yield valuable returns.

South of the fault plane the varying dip of the strata accords in places with the slope of the stream beds; and no information had appeared in that area that revealed what beds became thinner beneath the drift.

THE FAULT

The writer finds that the Thurman-Wilson fault of 300 feet near the Missouri river in Fremont County does not become an anticline¹ toward Stennett, but that it is a normal dip or slightly oblique fault, extending between Fox quarries in the extreme southern part of Cass County and Briscoe (three miles further east), with upthrow on the north side, with displacement of 284.5 feet, and with fault plane dipping steeply to the southeast. This line of fracture continues northeast across Adair County, either in a slightly curved line or in a parallel fault or faults (Fig. 1). The southeast part of Guthrie County is the limit toward the northeast to which the writer has thus far traced the evidence of faulting in the field.

At the few places where a measurement of dip was obtainable a marked irregularity of dip was found that in general was at right angles to the strike of the fault plane, and thus at right angles to

¹ G. L. Smith, "Carboniferous Section of Southwestern Iowa," *Iowa Geol. Surv.*, XIX (1909), 636.

the general dip of the strata in that quarter of the state. North of the fault the upthrow side has been removed by erosion till no escarpment has been left, while on the downthrow side the lesser amount of erosion has left strata far to the east, with offset of thirty-five and a half miles. North of the fault plane the strata beneath Lewis, Cass County, are seventy feet thinner than recorded in the log of the deep well at Clarinda, Iowa; and south of the fault

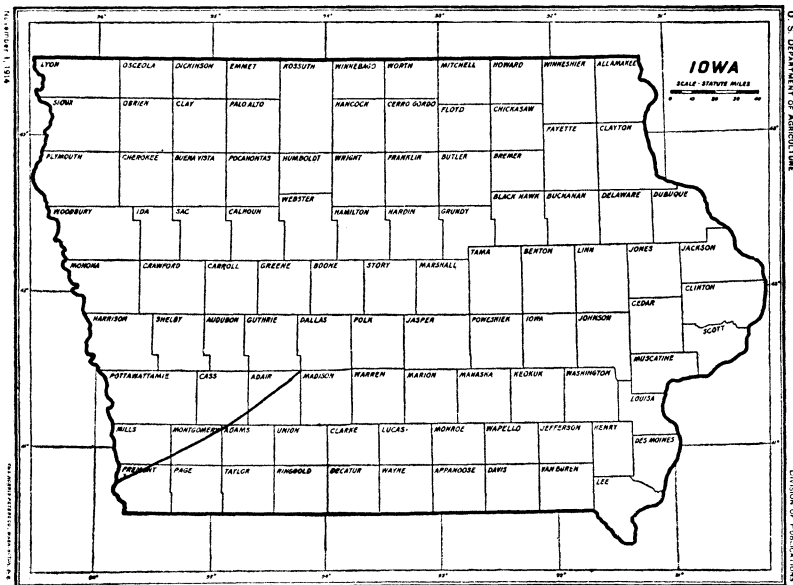


FIG. 1

plane they diminish in thickness 235 feet further within a distance of 41 miles from Briscoe, Adams County, to the "Backbone" west of Winterset, in Madison County. The most marked thinning is immediately beneath the Oread limestone, where in Missouri Hinds and Greene report a faunal break.¹ This is to be noted in contrasting a section northeast-southwest north of the fault plane with a parallel section south of the fault plane. The section from Reno to Briscoe across the fault plane connects these two sections (Fig. 2).

¹ Hinds and Greene, "Stratigraphy of the Pennsylvanian Series," *Missouri Bureau of Geology and Mines*, XIII (2d series, 1915), 155.

In order to express the relation of the beds that outcrop along Middle River in the eastern part of Adair County it has seemed desirable to represent the base of the Deer Creek substage as it meets the bed of Middle River, which in a straight line is ten and three-fourths miles northwest of the base of the Oread substage where it outcrops in Harrison township. As the strata rise to the north this makes it appear as if the Tecumsey shale became thicker to the northeast, when in reality all of the strata become thinner in that direction. In both these diagrams the dip is magnified eighty-eight and a third times.

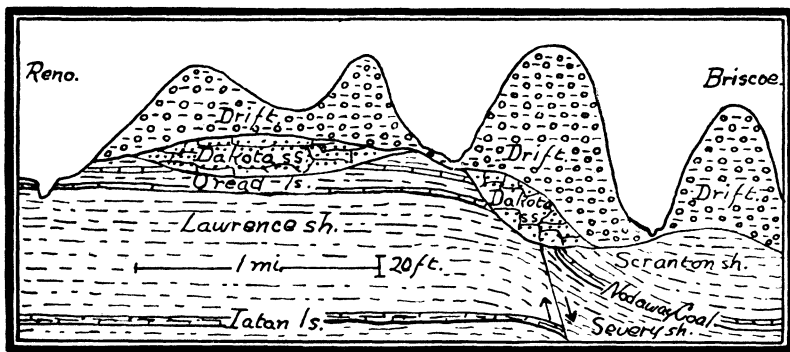


FIG. 2

The effect of this faulting on the location of outcrops is expressed in the block diagrams representing the changes that have taken place. It should be particularly noted that the limestone (Oread) which, on the north side of the fault plane, appears at Lewis and at the Fox quarries in the southwest part of Cass County, appears, on the south side of the fault plane, close to Middle River as it leaves Adair County, and also extends into the southwestern part of Madison County (Figs. 3 and 4).

IMPORTANT BEARINGS

Coal.—For the first time we now recognize why Nodaway coal found in the southern part of southwestern Iowa is not also found in the northern part of southwestern Iowa, except in a small area close to Thurman, Fremont County. Prior to this it was supposed

that the fault at Thurman changed into an anticline near Stennett, in which case there ought to be Nodaway coal north of the anticline. The recognition of the fault should prove of considerable economic value in preventing expenditure for prospecting for the Nodaway coal seam north of the fault.

The presence of the fault with uplift of 284 feet north of this fault plane is a new factor of importance bearing on the question

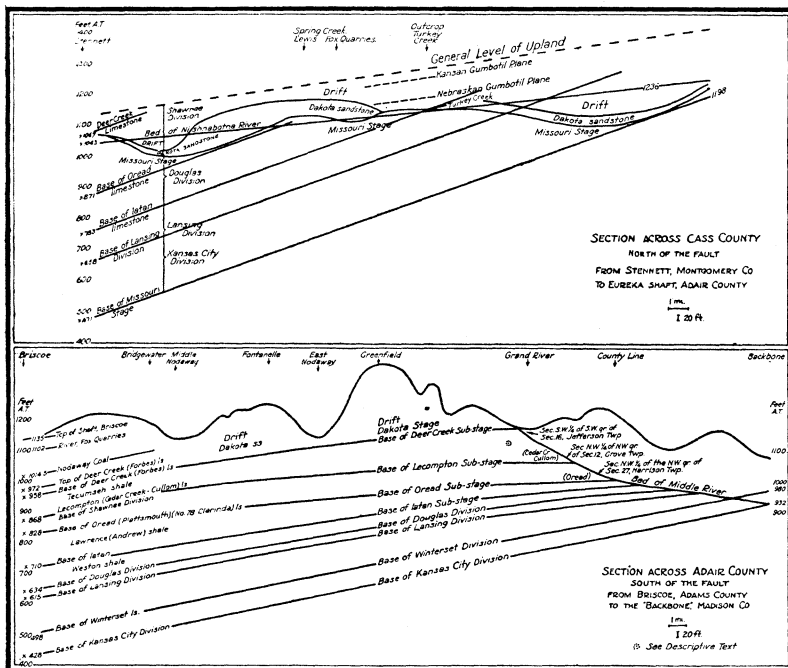


FIG. 3

of the depth of the Des Moines stage (the chief coal-bearing beds) farther north in the west central part of the state, even though the determination of the position of such beds is complicated by warping of the strata (if not by other faulting), by the great unconformity beneath them, and by the pre-Cretaceous erosion of their surface. The presence of thick beds of Dakota sandstone above the Des Moines stage and of thick deposits of drift above the

Dakota sandstone, apparently preclude the possibility of successful mines even if coal were located.

The presence of this fault and of others in a parallel direction with uplift to the north has also an important bearing with reference to the distribution of coal toward the north and northeast that is very noticeable in northern Adair and southern Guthrie and Dallas counties,¹ and, combined with erosion, explains the westward trend of exposures of the Des Moines stage in this region. It also introduces a new factor to combine with unconformity at the base of the Des Moines stage to explain why coal is found in certain localities (as near Panora and Boone) and not in others.

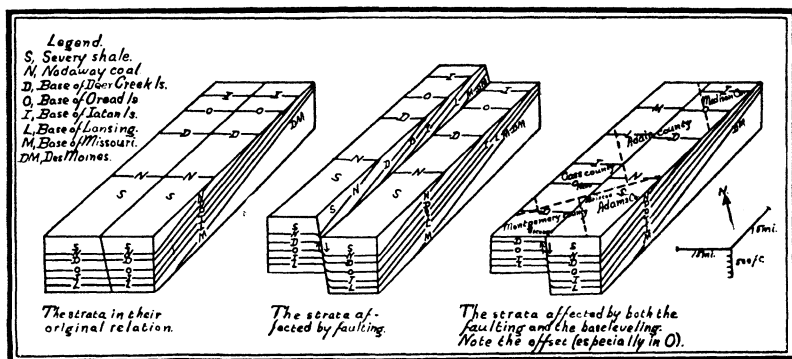


FIG. 4

Oil.—The presence of a dip fault extending through southwestern Iowa toward the oil fields farther southwest, with strata in Iowa monoclinal, dipping southwest, and crossed by low anticlines,² present a series of facts that cannot be overlooked with reference to oil, even though no traces of oil have been found. Across the river in Nebraska a little fault exists in Jones Point

¹ In view of the presence of this parallel fault Bain's report on Guthrie County makes very interesting reading (*Iowa Geol. Surv.*, Vol. VII). On pp. 428-29 he describes the upper division of the Des Moines stage as duplicating the lower division, and on p. 455 states that beds found "probably represent the upper portion of the Cherokee shales." Leonard (VIII, 91) speaks of an anticline in the southwestern part of Dallas County, the county next east of Guthrie County.

² George L. Smith, "Carboniferous Section of Southwestern Iowa," *Iowa Geol. Surv.*, XIX, 624.

that Todd¹ and Smith² thought a continuation of the Thurman-Wilson fault in Iowa. It seems strange that there should be a displacement of 300 feet on the Iowa side of the river and of but a few feet on the Nebraska side, and even more strange now that we know that the fault continues to the northeast with but little diminution of displacement to at least near the center of Iowa. Perhaps there is a displacement further north or south in Nebraska that has not yet been located.

Why no oil has been found in southwestern Iowa, southeastern Nebraska, and northeastern Kansas has received no satisfactory explanation as yet in published reports. With the consent of G. E. Condra, professor of geography and conservation at the University of Nebraska, I call attention to his oral statement that in the southeastern part of Nebraska granite was found at a depth of five hundred feet from the surface and penetrated for a depth of a thousand feet. This great mass of granite lies between southwestern Iowa and the oil fields further southwest, and, whatever other conditions are involved, bars underground circulation through formations that farther southwest are oil-bearing.

Border of the Missouri stage.—North of the fault plane (the upthrow side) erosion has given the east-west trend of the Missouri stage in Guthrie County. South of the fault plane (the downthrow side) the base of the Missouri stage extends far to the east. The extension to the eastward is thus not simply an uneroded mass of a highland region, as formerly supposed, but an uneroded portion left protected on the downthrow side³ of a fault plane. Still further to the northeast, even to the "Driftless Area," along the general direction of the Thurman-Wilson fault may be noted east-west extensions of the various formations as mapped, as if the effect

¹ J. E. Todd, "On the Folding of the Carboniferous Strata in Southwestern Iowa," *Proc. of the Iowa Acad. of Sci.*, I, Part I (1889), 61; also XIII (1906), 184.

² G. L. Smith, "Carboniferous Section of Southwestern Iowa," *Iowa Geol. Surv.*, XIX (1909), 612.

³ No one has as yet determined whether or not a continuation of Keyes's Cap-au-Gres fault bounds the eastern side of the Missouri stage in Iowa. He describes the fault as extending from Leon, Iowa, southeast to Vincennes, Indiana, but he gives no data with reference to the Iowa end of the line ("Extent and Age of the Cap-au-Gres Fault," *Proc. of the Iowa Acad. of Sci.*, XXIV [1917], 61).

of the disturbance were a factor in determining surface distribution well across the state. Investigation has not, however, by the writer been extended in the field to this part of the state.

AGE OF THE FAULT

Since the Dakota sandstone lies on both sides of the fault plane and rests on the truncated surface of various strata of the Missouri stage with no evidence of a fault scarp detected beneath the Dakota sandstone, it appears that the faulting began in the interval between the deposition of the Missouri stage and the deposition of the Dakota stage, that the fault scarp was well removed before the subsidence that accompanied the deposition of the Dakota sandstone, and that any additional faulting has not been very pronounced since that time. That there has been some later movement is possible, since at Crystal Lake shale included between the sandstone strata is found to dip in the general direction of the dip of the limestone (Missouri). If there was any movement along the fault plane any escarpment that formed at the surface of the sandstone has since been removed by erosion.

Variations in dip of the sandstone that correspond to variations in dip of the limestone along the fault plane have not been detected. It therefore appears from this argument also that about all faulting with accompanying disturbance¹ was completed before the Dakota sandstone was laid down. In this interval of time there was in the interior and eastern United States one marked period of disturbance, the Permian. In distant regions (Appalachian and Ouachita) the faulting was of the reversed type. Here it is of the normal type. The reversed faulting of the Permian may have been accompanied or followed by relaxational movements in the same or the next period. To this interval of time (Permian-Triassic) it at present seems necessary to refer the major part of the faulting, and perhaps all of it.

¹ From a study of the joint planes it also appears that the jointing in the Missouri stage is related to the faulting and to the uplift toward the northeast (Permian-Triassic), while the jointing in the sandstone is related to the uplift toward the northwest (post-Cretaceous), though affected by the presence of the fault plane and the joint planes, and also affecting those planes.